

11/22/00
JC960 U.S. PTO

11-24-00

PTO/SB/05 (4/98)

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Approved for use through 09/30/2000. OMB 0651-0032

Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No

A01138

First Inventor or Application Identifier

Eric Alvin Johnson et al

Title

Polymeric Binders For Ink Jet Inks

Express Mail Label No

EE150161900US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents

ADDRESS TO

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Box Patent Application
Washington, DC 20231

1. ☒ *Fee Transmittal Form (e.g., PTO/SB/17)
(Submit an original and a duplicate for fee processing)
2. ☒ Specification [Total Pages (preferred arrangement set forth below)
 - Descriptive title of the Invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
3. ☐ Drawing(s) (35 U.S.C. 113) [Total Sheets - 4. ☒ Oath or Declaration [Total Pages - a. ☒ Newly executed (original or copy)
- b. ☒ Copy from a prior application (37 C.F.R. § 1.63(d))
(for continuation/divisional with Box 16 completed)
 - i. ☐ **DELETION OF INVENTOR(S)**
Signed statement attached deleting
inventors(s) named in the prior application,
see 37 C.F.R. § 1.63(d)(2) and 1.33(b).

5. ☐ Microfiche Computer Program (Appendix)
6. ☐ Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)
 - a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy (identical to computer copy)
 - c. ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. ☐ Assignment Papers (cover sheet & document(s))
8. ☐ 37 C.F.R. § 3.73(b) Statement ☐ Power of Attorney
(when there is an assignee)
9. ☐ English Translation Document (if applicable)
10. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
11. ☒ Preliminary Amendment
12. ☒ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
13. ☐ *Small Entity ☐ Statement filed in prior application,
Statement(s) Status still proper and desired
(PTO/SB/09-12)
14. ☐ Certified Copy of Priority Document(s)
(if foreign priority is claimed)
15. ☐ Other: _____

*NOTE FOR ITEMS 1 & 13 IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP)

of prior application No 60/170,555 filed 12/14/99

Prior application information Examiner _____

Group / Art Unit _____

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

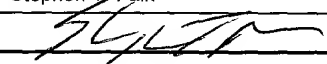
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or ☒ Correspondence address below

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Signature		Date	11/22/00

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Small Entity payments must be supported by a small entity statement,
otherwise large entity fees must be paid See Forms PTO/SB/09-12.
See 37 CFR §§ 1.27 and 1.28

Complete if Known

Application Number	
Filing Date	Herewith
First Named Inventor	Eric Alvin Johnson et al
Examiner Name	
Group / Art Unit	
Attorney Docket No	A01138

TOTAL AMOUNT OF PAYMENT (\$ 790

METHOD OF PAYMENT (check one)		FEE CALCULATION (continued)																																																																																																																																																																													
1. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to. Deposit Account Number: 18-1850 Deposit Account Name: Rohm and Haas Company <input checked="" type="checkbox"/> Charge Any Additional Fee Required Under 37 CFR §§ 1.16 and 1.17		3. ADDITIONAL FEES <table border="1"> <thead> <tr> <th>Large Entity Fee Code</th> <th>Small Entity Fee Code</th> <th>Fee Description</th> <th>Fee Paid</th> </tr> </thead> <tbody> <tr><td>105</td><td>130</td><td>205</td><td>65</td><td>Surcharge - late filing fee or oath</td><td></td></tr> <tr><td>127</td><td>50</td><td>227</td><td>25</td><td>Surcharge - late provisional filing fee or cover sheet</td><td></td></tr> <tr><td>139</td><td>130</td><td>139</td><td>130</td><td>Non-English specification</td><td></td></tr> <tr><td>147</td><td>2,520</td><td>147</td><td>2,520</td><td>For filing a request for reexamination</td><td></td></tr> <tr><td>112</td><td>920*</td><td>112</td><td>920*</td><td>Requesting publication of SIR prior to Examiner action</td><td></td></tr> <tr><td>113</td><td>1,840*</td><td>113</td><td>1,840*</td><td>Requesting publication of SIR after Examiner action</td><td></td></tr> <tr><td>115</td><td>110</td><td>215</td><td>55</td><td>Extension for reply within first month</td><td></td></tr> <tr><td>116</td><td>390</td><td>216</td><td>195</td><td>Extension for reply within second month</td><td></td></tr> <tr><td>117</td><td>890</td><td>217</td><td>445</td><td>Extension for reply within third month</td><td></td></tr> <tr><td>118</td><td>1,390</td><td>218</td><td>695</td><td>Extension for reply within fourth month</td><td></td></tr> <tr><td>128</td><td>1,890</td><td>228</td><td>945</td><td>Extension for reply within fifth month</td><td></td></tr> <tr><td>119</td><td>310</td><td>219</td><td>155</td><td>Notice of Appeal</td><td></td></tr> <tr><td>120</td><td>310</td><td>220</td><td>155</td><td>Filing a brief in support of an appeal</td><td></td></tr> <tr><td>121</td><td>270</td><td>221</td><td>135</td><td>Request for oral hearing</td><td></td></tr> <tr><td>138</td><td>1,510</td><td>138</td><td>1,510</td><td>Petition to institute a public use proceeding</td><td></td></tr> <tr><td>140</td><td>110</td><td>240</td><td>55</td><td>Petition to revive - unavoidable</td><td></td></tr> <tr><td>141</td><td>1,240</td><td>241</td><td>620</td><td>Petition to revive - unintentional</td><td></td></tr> <tr><td>142</td><td>1,240</td><td>242</td><td>620</td><td>Utility issue fee (or reissue)</td><td></td></tr> <tr><td>143</td><td>440</td><td>243</td><td>220</td><td>Design issue fee</td><td></td></tr> <tr><td>144</td><td>600</td><td>244</td><td>300</td><td>Plant issue fee</td><td></td></tr> <tr><td>122</td><td>130</td><td>122</td><td>130</td><td>Petitions to the Commissioner</td><td></td></tr> <tr><td>123</td><td>50</td><td>123</td><td>50</td><td>Petitions related to provisional applications</td><td></td></tr> <tr><td>126</td><td>240</td><td>126</td><td>240</td><td>Submission of Information Disclosure Stmt</td><td></td></tr> <tr><td>581</td><td>40</td><td>581</td><td>40</td><td>Recording each patent assignment per property (times number of properties)</td><td></td></tr> <tr><td>146</td><td>710</td><td>246</td><td>355</td><td>Filing a submission after final rejection (37 CFR § 1.129(a))</td><td></td></tr> <tr><td>149</td><td>710</td><td>249</td><td>355</td><td>For each additional invention to be examined (37 CFR § 1.129(b))</td><td></td></tr> <tr><td colspan="5">Other fee (specify) _____</td><td></td></tr> <tr><td colspan="5">Other fee (specify) _____</td><td></td></tr> </tbody> </table>		Large Entity Fee Code	Small Entity Fee Code	Fee Description	Fee Paid	105	130	205	65	Surcharge - late filing fee or oath		127	50	227	25	Surcharge - late provisional filing fee or cover sheet		139	130	139	130	Non-English specification		147	2,520	147	2,520	For filing a request for reexamination		112	920*	112	920*	Requesting publication of SIR prior to Examiner action		113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action		115	110	215	55	Extension for reply within first month		116	390	216	195	Extension for reply within second month		117	890	217	445	Extension for reply within third month		118	1,390	218	695	Extension for reply within fourth month		128	1,890	228	945	Extension for reply within fifth month		119	310	219	155	Notice of Appeal		120	310	220	155	Filing a brief in support of an appeal		121	270	221	135	Request for oral hearing		138	1,510	138	1,510	Petition to institute a public use proceeding		140	110	240	55	Petition to revive - unavoidable		141	1,240	241	620	Petition to revive - unintentional		142	1,240	242	620	Utility issue fee (or reissue)		143	440	243	220	Design issue fee		144	600	244	300	Plant issue fee		122	130	122	130	Petitions to the Commissioner		123	50	123	50	Petitions related to provisional applications		126	240	126	240	Submission of Information Disclosure Stmt		581	40	581	40	Recording each patent assignment per property (times number of properties)		146	710	246	355	Filing a submission after final rejection (37 CFR § 1.129(a))		149	710	249	355	For each additional invention to be examined (37 CFR § 1.129(b))		Other fee (specify) _____						Other fee (specify) _____					
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SUBMITTED BY		Complete (if applicable)	
Name (Print/Type)	Stephen T. Falk	Registration No (Attorney/Agent)	36,795
Signature		Telephone	215-592-6745
		Date	11/22/00

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PATENT APPLICATION

of

ERIC ALVIN JOHNSON
ROBERT DAVID SOLOMON
MICHAEL HALLDEN ABBERTON
CARL MICHAEL HESLER

for

POLYMERIC BINDERS FOR INK JET INKS

DN A01138

GJB/sd

U.S. Postal Service Express Mail No. EF150161900US

Polymeric Binders for Ink Jet Inks

This invention concerns polymeric binders which are suitable for use in ink jet inks. More specifically, this invention relates to polymeric binders formed by polymerization of a monomer mixture comprising a polymerizable surfactant monomer.

Certain ink jet inks comprise a liquid medium, a colorant, such as a pigment or dye, a binder or resin to aid in dispersing the pigment in the medium and to affix the colorant to the print surface. In order to create more durable print quality, particularly in terms of color-fastness and water- and rub-resistance of the printing ink, there has been interest in preparing ink jet inks in which the colorant is an insoluble pigment, rather than a water soluble dye. The latter are generally absorbed to some degree by the paper or other print medium, but due to their inherent water-solubility do not offer good waterfastness. Pigment-based inks are generally deposited on the surface of the print medium, making them susceptible to removal by water or abrasion. However, as a result of the physical properties of pigments, pigment based ink compositions have a tendency to have a low wet-rub resistance and low highlighter resistance.

The term "wet-rub," as used herein, means applying abrasive pressure across the printed substrate with a wetted paper facial tissue and measuring any smear created thereby; wet-rub differs from waterfastness because abrasion is used. The term "highlighter resistance," as used herein, means applying abrasive pressure across a printed substrate with a commercially available highlighting marker and measuring any smear created thereby; an example of such marker is Sanford Corp. Major Accent brand highlighting markers. The term "print quality", as used herein, means an accumulative evaluation of the overall performance of an ink jet ink as measured by the appearance of a printed page of combined text and graphics, including edge sharpness, bleed, feathering, optical density, wet-rub resistance, highlighter resistance and print operability. The term "print operability", as used herein, means an accumulative evaluation of printer performance, including print appearance and uniformity, page after page longevity of print quality and uniformity, nozzle drop outs, print head maintenance problems, and the ability to stop and restart printing.

Polymer binders have been added to ink jet ink compositions to improve durability, to improve print quality and to reduce color bleeding and feathering. However, the inclusion of such binders can result in increased printhead maintenance problems, including clogging of the nozzles and kogation, i.e.

5 formation of film on or about the heater. Also, polymers may tend to form films on the nozzle plate. The addition of polymers to ink jet ink compositions also may cause decreased pigment dispersion stability and interference with bubble formation.

EP-A-0869 160 discloses an inkjet ink formulation with colorant, vehicle
10 and resin emulsion containing ionic carboxylic groups on the surface of resin emulsion particles to cause disassociation of the colorant and resin particles. The resin has 1 to 40 wt.% "carboxylic acid groups", and Tg of 0 to 120°C. Exemplified embodiments of the resin include copolymers of butyl acrylate, methyl methacrylate and (meth)acrylic acid, with 3 to 20 wt.% acid, Tg of 53 to
15 95°C and particle size of 63 to 235 nm, utilizing high Tgs and low particle sizes.

EP-A-0747456 discloses a method for providing a waterborne coating composition, such as a paint, having improved color acceptance. The coating composition contains an emulsion-polymerized addition polymer formed from a mixture of monomers including a polymerizable surfactant monomer. There is no
20 disclosure of the use of the addition polymer in an ink.

It is an object of the present invention to provide a polymeric binder for use with a colorant to form an ink jet ink that demonstrates an improved print quality, as expressed by an improvement in one or more properties used to determine print quality, which improvement is achieved without any significant
25 detrimental effect on the other properties used to determine print quality.

In accordance with the present invention, there is provided a polymeric binder suitable for use in an ink composition, preferably an ink jet ink composition, comprising a colorant and a polymeric binder, wherein the polymeric binder is an emulsion-polymerized addition copolymer formed from a
30 monomer mixture comprising ethylenically unsaturated monomers including from more than 4 to 15 wt % based on the weight of said mixture of at least one ethylenically unsaturated carboxylic acid functional monomer, and from 0.05 to

5 wt % based on the weight of said mixture of at least one polymerizable surfactant monomer comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it.

5 In another aspect, there is provided an ink composition, preferably an ink jet composition, comprising a colorant and a polymeric binder, wherein the polymeric binder is an emulsion-polymerized addition copolymer formed from a monomer mixture comprising ethylenically unsaturated monomers including from more than 4 to 15 wt % based on the weight of said mixture of at least one
10 ethylenically unsaturated carboxylic acid functional monomer, and from 0.05 to 5 wt % based on the weight of said mixture of at least one polymerizable surfactant monomer comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it.

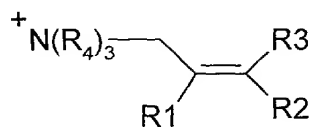
15 In yet another aspect of the present invention, there is provided the use of an emulsion-polymerized addition copolymer, formed from a monomer mixture comprising ethylenically unsaturated monomers including from more than 4 to 15 wt % based on the weight of said mixture of at least one ethylenically unsaturated carboxylic acid functional monomer and from 0.05 to 5 wt % based
20 on the weight of said mixture of at least one polymerizable surfactant monomer comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it, as a polymeric binder in an ink composition, preferably an ink jet composition, to improve the print quality of said ink composition.

25 Surprisingly, ink jet inks comprising a binder of the present invention demonstrate improved print quality over binders of similar composition but which do not comprise a polymerized surfactant monomer. In addition, ink jet inks of the present invention may demonstrate an improved optical density. Polymerizable surfactant monomers are known in the art. They are surface
30 active compounds having a polymerizable group, such as an allyl, acryl methacryl or methallyl group (also referred to herein as (meth)acryl and (meth)allyl), and which may be used as an emulsifier in an emulsion

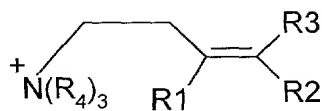
polymerization. Thus, the polymerizable surfactant functions as both a surfactant and as a comonomer. The polymerizable surfactant may be cationic, anionic or nonionic. Suitable polymerizable surfactant monomers comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it, include, for example, anionic surfactant monomers such as sulphates, phosphates, sulposuccinate half esters, and sulposuccinate diesters bearing copolymerizable reactive groups and nonionic surfactant monomers. Preferred polymerizable surfactant monomers comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it are selected from the group of relevant monomers consisting of allylammonium C₈-C₂₂ alkyl-12EO-phosphate (for example as X-2263-26 from Stepan); allylammonium C₈-C₂₂ alkyl-7EO-phosphate (for example as X-2263-27b from Stepan); allylammonium C₈-C₂₂ alkyl-3EO-phosphate (for example as X-2263-28b from Stepan); allylammonium linear-dodecyl benzene sulfonate (for example as AU-1 from Stepan); allylammonium lauryl-sulfate (for example as AU-5 from Stepan); and allyl ammonium alkylether-sulfate (for example as NMS-7 from Stepan). Suitable polymerizable surfactant monomers comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it, also include, for example, acrylate ethoxylates as described in US-A-5162475, diallylamine PO/EO copolymers (as described in US-A-5478883), and maleate derivatives (as described in US-A-4246387).

Preferably, the hydrophilic functional group comprises within it a polymerizable group which is an ethylenically unsaturated amine cation. Examples of suitable ethylenically unsaturated amine cations are the non-cyclic cations of Formulas I to III, the cyclic cations of Formulas IV to VIII and the non-cyclic butadiene,

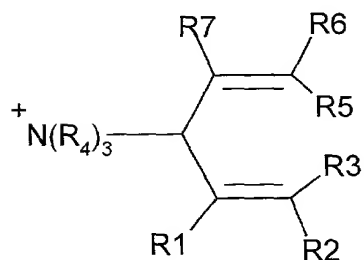
pentadiene, and hexadiene analog cations of Formulas IV to VIII:



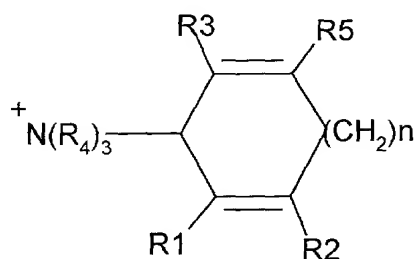
I



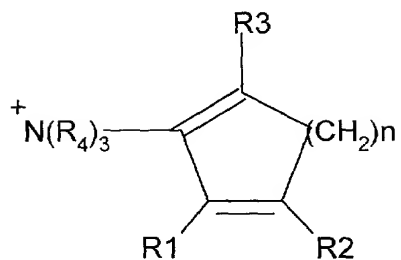
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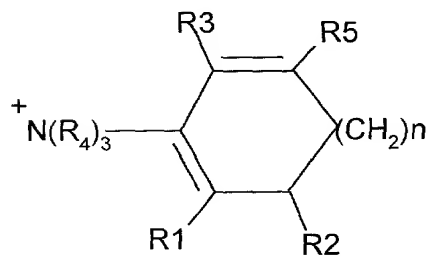
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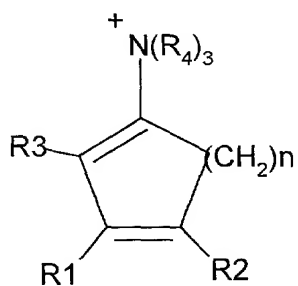
IV



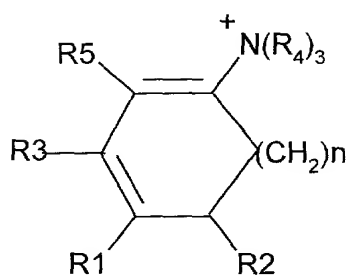
V



VI



VII



VIII

where n is in the range 0 to 8, each of R_1 , R_2 , R_3 , R_5 , R_6 , and R_7 groups is

5 independently selected from the group consisting of H, substituted or unsubstituted C_1 - C_8 alkyl and substituted or unsubstituted C_6 - C_{12} aryl, and each

R_4 is independently selected from the group consisting of H and substituted or unsubstituted C_1 - C_8 alkyl. More preferably, the polymerizable group comprises a cation of Formula I. Examples of particular ethylenically unsaturated amine cations which may be suitable for use in the present invention include the following: 9H-Fluoren-9-amine; 3,4-dihydropyridine; 1,4 dihydro pyridine; 2,3,4,5-tetrahydro pyridine; 1,2,3,6,-tetrahydro pyridine; 3-pyrroline; 1,3-Butadien-1-amine; 5-amino-1,3-cyclopentadiene; 1,3-Cyclohexadiene-1-carboxylic acid, 5-amino-, methyl ester; 1,4-Cyclohexadiene-1-carboxylic acid, 3-amino-, methyl ester; Bicyclo[2.2.1]hept-2-en-7-amine; Bicyclo[2.2.1]hept-5-en-2-amine, 2-Norbornen-1-amine, 2-Bornanamine, and N,N-diethylaminoisoprene. In general, the ethylenically unsaturated amine cations, such as those of Formulas I to VIII, may be obtained from the group of ethylenically unsaturated allylic, benzylic, or dienyl amines or isomers of those amines. The polymerizable surfactant comprising such ethylenically unsaturated amine cations may be formed from the amine and any suitable long chain hydrophobic organic or inorganic acid such as dodecylbenzenesulfonic acid, dodecanoic acid, and aromatic phosphonic acids.

The amount of polymerizable surfactant monomer in the monomer mix is preferably from 0.075 to 2 wt %, more preferably 0.075 to 0.5 wt %, based on the weight of said mixture.

The ethylenically unsaturated carboxylic acid functional monomers are preferably C_3 to C_{20} ethylenically unsaturated carboxylic acids, more preferably monomers selected from the group consisting of acrylic acid, methacrylic acid, itaconic acid, fumaric acid, maleic acid and anhydrides of such acids; their basic salts e.g. the ammonium, lithium, sodium and potassium salts thereof; and mixtures of such monomers. Alternatively, the ethylenically unsaturated carboxylic acid monomer may be an oligomer of acrylic or methacrylic acid, preferably having a molecular weight of no more than 5000 Daltons.

The amount of ethylenically unsaturated carboxylic acid monomer in the monomer mix is preferably from more than 4 to 10 wt %, more preferably from 4.5 to 9 wt %, based on the weight of said mixture.

Other ethylenically unsaturated monomers suitable for use in said monomer mix include one or more monomers selected from, but not limited to: substituted e.g. hydroxy- or acetoacetoxy-substituted and unsubstituted (C_1 to C_{50} , preferably C_1 - C_{22} , most preferably C_1 to C_{18}) alkyl (meth) acrylates, styrene and substituted styrenes, vinyl acrylates, vinyl acetates, fluoromethacrylates, acrylamide, substituted acrylamides, methacrylamides, substituted methacrylamides, and combinations thereof. Among the esters of acrylic acid and methacrylic acid, preferred monomers include methyl acrylate, ethyl acrylate, propyl acrylate, butyl acrylate, ethylhexyl acrylate, lauryl acrylate, methyl methacrylate, ethyl methacrylate, propyl methacrylate, butyl methacrylate, lauryl methacrylate, isobutylene methacrylate, styrene, acrylamide, vinyl acrylate, vinyl acetate, hydroxyethyl acrylate and hydroxyethyl methacrylate.

In one embodiment, the binder comprises an addition copolymer of ethylhexyl acrylate, methyl methacrylate, methacrylic acid and allyl ammonium dodecyl benzene sulfonate

Preferably the binder comprises an addition polymer with a glass transition temperature, T_g , of at least -40°C , more preferably in the range from -35 to about 120°C , yet more preferably in the range from -35 to 20°C , and even more preferably in the range from -30 to 10°C . T_g can be determined by the Fox equation.

In a preferred embodiment, the polymer binder comprises a single stage addition polymer with an average diameter in the range from about 100 to 400 nm. More preferably, the average diameter is in the range 200 to 350 nm. The average particle diameter may be determined by a light scattering technique, such as by employing a Brookhaven Instruments Corporation, "BI-90 Particle Sizer" analyzer.

The particle size distribution of the binder polymer may be unimodal, bimodal or polymodal, but modality is not considered important to the practice of this invention.

The molecular weight of the polymeric binder is not critical. However, it has been found that the binder polymers preferably has a molecular weight in

the range from about 10,000 to about 2,000,000 Daltons; more preferably, 50,000 to 1,000,000 Daltons. The molecular weight as used herein is defined as the weight average molecular weight and may be determined by gel permeation chromatography in THF as solvent.

5 The ink composition of the present invention may further comprise additional components including without limitation process aids such as other (free) surfactants, protective colloids, and other stabilizers known to those skilled in the art. Suitable surfactants, for example, include sodium lauryl sulfate, sodium dodecylbenzene sulfonate, sodium dioctyl sulfosuccinate, and ammonium
10 perfluoralkyl sulfonates, Triton X-100, Triton X-405, and polyoxyethylenated polyoxypropylene glycols.

The addition polymer may be prepared by a conventional persulfate-initiated thermal process known in the art such as batch, semi-batch, gradual addition or continuous, for example as described in EP-A-0747456. The
15 monomers are polymerized to preferably greater than 99% conversion and then the reaction is cooled to room temperature (20-25°C) after the addition of the appropriate amount of neutralizing base to control pH. The pH is adjusted to between pH 7-10, more preferably between pH 8-9, with neutralizer such as, for example, ammonia, lithium hydroxide, sodium hydroxide, potassium hydroxide
20 or combinations of these neutralizers.

The binder may be incorporated in an ink composition, preferably an ink jet ink composition, comprising, for example, pigment, binder and an aqueous medium. Preferably, the binder is present at a level of 0.1 to 10 weight percent, preferably, 0.5 to 8 weight percent, more preferably 1 to 5 weight percent
25 relative to the total weight of the ink composition. The aqueous carrier may be water; preferably, deionized water. In one embodiment, the aqueous carrier is present at from about 40% to about 95%, preferably from about 55% to about 80%, most preferably, from about 70% to about 80% by weight of the ink composition. Selection of a suitable mixture for the ink composition using the
30 binder of the present invention depends upon the requirements of the specific ink being formulated, such as the desired surface tension and viscosity, the pigment

used, the drying time required for the pigmented ink and the type of paper onto which the ink will be printed.

The ink composition using the binder of the present invention may also include water miscible materials such as humectants, dispersants, penetrants, chelating agents, co-solvents, defoamers, buffers, biocides, fungicides, viscosity modifiers, bactericides, surfactants, anti-curling agents, anti-bleed agents and surface tension modifiers, all as is known in the art. Useful humectants include ethylene glycol, 1,3 propanediol, 1,4 butanediol, 1,4 cyclohexanedimethanol, 1,5 pentanediol, 1,6 hexanediol, 1,8 octanediol, 1,2 propanediol, 1,2 butanediol, 1,3 butanediol, 2,3 butanediol, diethylene glycol, triethylene glycol, tetraethylene glycol, polyethylene glycol with average molecular weight of 200, 300, 400, 600, 900, 1000, 1500 and 2000, dipropylene glycol, polypropylene glycol with average molecular weight of 425, 725, 1000, and 2000, 2-pyrrolidone, 1-methyl-2-pyrrolidone, 1-methyl-2-piperidone, N-ethylacetamide, N-methylpropionamide, N-acetyl ethanolamine, N-methylacetamide, formamide, 3-amino-1, 2-propanediol, 2,2-thiodiethanol, 3,3-thiodipropanol, tetramethylene sulfone, butadiene sulfone, ethylene carbonate, butyrolacetone, tetrahydrofurfuryl alcohol, glycerol, 1,2,4-butenetriol, trimethylpropane, pantothenol, Liponic EG-1. Preferred humectants are polyethylene glycol with average molecular weight of 400 to 1000, 2-pyrrolidone 2,2 thiodiethanol, and 1,5 pentanediol. Preferred penetrants include n-propanol, isopropyl alcohol, 1,2 hexanediol, and hexyl carbitol.

Examples of colorants useful in the method of the present invention are selected from the group of pigments and dyes generally useful in ink jet printing. Suitable organic pigments include carbon black, azo compounds, phthalocyanine pigments, quinacridone pigments, anthraquinone pigments, dioxazine pigments, indigo, thioindigo pigments, perynone pigments, perylene pigments, and isoindolene. Suitable inorganic pigments include titanium dioxide, iron oxide, and other metal powders. The amount of pigment is generally determined by the desired properties of the ink to be made. Generally, the amount of pigments used is less than 10% and is typically from 3-8% by weight based on the total weight of all the components of the ink. The pigment particle size must be sufficiently small that pigment particles will not clog the nozzles on the printing

device in which the ink is to be used. Typical nozzle openings on thermal ink jet printers are 30-60 microns in diameter. Preferably, the pigment particle size is from 0.05 to 2 microns, more preferably not more than one micron and most preferably not more than 0.3 microns.

5 The amount of humectant used is determined by the properties of the ink and may range from 1-30%, preferably from 5-15% by weight, based on the total weight of all the components in the ink. Examples of commonly used humectants useful in forming the ink are: glycols, polyethylene glycols, glycerol, ethanolamine, diethanolamine, alcohols, and pyrrolidones. Other humectants
10 known in the art may be used as well.

 The use of suitable penetrants will depend on the specific application of the ink. Useful examples include pyrrolidone, and N-methyl-2-pyrrolidone.

 The amount of defoaming agent in the ink, if used, will typically range from 0.05-0.5% by weight, and is more typically 0.1 wt.%. The amount required
15 depends on the process used in making the pigment dispersion component of the ink. Defoaming agents useful in forming aqueous dispersions of pigments are well known in the art and commercially available examples include Surfynol 104H and Surfynol DF-37 (Air Products, Allentown, PA).

 The remaining portion of the ink is generally water. The amount of water
20 preferably is from 65-90% by weight, more preferably from 75-85% by weight, based on the total weight of all the components in the ink.

 The ink compositions of the present invention may be prepared by any method known in the art for making such compositions, for example, by mixing, stirring or agitating the ingredients together using any art recognized technique
25 to form an aqueous ink. The procedure for preparation of the ink composition of the present invention is not critical except to the extent that the ink composition is homogenous.

 One method for preparation is as follows: Mix the aqueous carrier, humectant(s), surfactant(s) and penetrant(s) for 10 minutes, or until
30 homogenous. Prepare pigment-dispersant mixture by milling a 5 to 1 ratio of pigment to dispersant to a total of 20% solids in water. Slowly add aqueous carrier/humectant/surfactant/penetrant solution to pigment-dispersant while

pigment(s) remains stirring. Let stir for another 10 minutes, or until homogeneous. Slowly add the pigment dispersion/carrier/humectant/ surfactant to the polymeric binder with stirring. Continue to stir for 10 minutes or until homogenous. Adjust pH of the resultant ink to 8.2 – 8.5 (e.g. by adding sufficient 20% NH₄OH). Filter through a 1 micrometer filter.

It is expected that the ink compositions using the binders of the present invention would include any additives necessary to obtain the desired physical properties required for the end use of the ink composition such additives include chelating agents, buffers, biocides, fungicides, antioxidants, rheology modifiers, thickeners, bacteriocides, surfactants, anti-curling agents, anti-bleed agents and surface tension modifiers, all as discussed above.

The invention in some of its embodiments will now be further described by reference to the following examples:

EXAMPLES

The experiments described below are intended to show the effect of using a polymeric binder comprising a polymerized surfactant monomer in an ink jet ink to improve its print quality. Polymeric binders of the present invention comprise a polymerized surfactant monomer comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it, and are identified in the worked examples with an asterisk. In each case, the polymeric binder was formulated into an in jet ink of Formulation 1 or Formulation 2 and the ink was applied to a paper (Hewlett Packard Bright White Ink Jet Paper) substrate.

Ink Jet Ink Formulation 1

	Weight
n-MethylPyrollidone	6.5g
PolyEthyleneGlycol	4.0g

Ink Jet Ink Formulation 2

	Weight
n-MethylPyrollidone	6.4g
PolyEthyleneGlycol	4.0g

Dispersion	25.0g	Dispersion	24.8g
Propanediol	10.2g	Propanediol	4.8g
Polymer Binder	20.0g	Liponics EG-1	2.0g
Water	54.3g	Surfynol 104E	0.4g
Total	120.0g	Polymer Binder	20.0g
		Water	57.6g
		Total	120.0g

Liponics EG-1 is a dispersant available from Lipo Chemicals, New Jersey. Surfynol 104E is a dispersant available from Air Products, PA.

Several different ink jet printers were used. These include the Hewlett
 5 Packard DeskJet 540, 690C, and 890C printers. All of these are thermal (bubble jet) drop on demand type printers. Print samples were allowed to dry for at least one hour before evaluation or the drying was accelerated by oven drying for 10 minutes at 85°C.

After application, the print was evaluated as follows:

- 10 Optical density (OD) was measured on a Macbeth 1200 Color Checker. Wet rub resistance (WR) was measured by wiping a wetted Kleenex facial tissue across a 2.5cm block of solid, filled print area. The resistance to smudging was rated on a 1 to 5 scale where 5 indicates no smudging and 1 indicated smudging equal to the pigmented Hewlett Packard ink sold for that specific printer.
- 15 Highlighter resistance was rated by using commercially available acidic and alkaline highlighters to highlight a printed text area. The rating indicates the number of times the highlighter was wiped over the same text area before significant smudging was noted. A maximum of ten highlighter wipes were tried on a sample. Responses of 10 can be interpreted as 10 or greater.
- 20 Print quality was rated by judging the appearance of a printed page of combined text and graphics. Edge sharpness, bleed, feathering, wet-rub resistance, highlighter resistance and print operability were accumulated into this evaluation. The scale is the linear combination of 3 times the optical density, the

highlighter performance, the wet rub performance and the print operability rating.

Print operability was rated by judging the printer performance. Print appearance and uniformity, page after page longevity of print quality and

5 uniformity, nozzle drop outs, print head maintenance problems and the ability to stop and restart were accumulated into this evaluation. The scale ranges from 0 to 5 where 0 was inoperable, 1 was poor and 5 was excellent.

Example 1

An addition polymer was prepared in accordance with the following general procedure:

10 A three liter flask was charged with 960g of deionized water, placed under a nitrogen atmosphere, and heated to 85°C. A monomer emulsion consisting of 275g 2-ethylhexyl acrylate (52parts), 227 g methyl methacrylate (43parts), 27 g methacrylic acid (5parts), 1.5 g of TREM LF-40 solution (36 %, Henkel Corp.),
15 and 177 g deionized water was separately prepared. Prior to addition of this emulsion to the kettle, ammonia (24g of a 4.8%-9.6% aqueous solution), ammonium persulfate (11g of a 9.6% solution), and a 54nm acrylic polymer seed (22.5g of a 22.8% solution) were added to the kettle. The monomer emulsion was then fed to the kettle with stirring at a rate of 3.9g/min. for 20
20 min. along with a solution of 24.6g of 2.24% aqueous ammonium persulfate at a rate of 0.2 g/min., followed by 100 minutes at 6.4 and 0.20 g/min., respectively, and a hold period of 20 min. The mixture was then cooled to 60°C, and a mixture of 2.6g of 0.15% ferrous sulfate followed by 3.2g of 4.4% t-butyl hydroperoxide and 6.1g of 1.6% sodium formaldehyde sulfoxylate was added and held for 20
25 min., followed by a second identical portion of tBHP and SFS. The mixture was then cooled, filtered, and sufficient 29% aqueous ammonia was added to adjust the pH to a range of 8.0-9.0 (final polymer binder = 30% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 8.2)

Examples 2 to 53

30 The procedure recited above was repeated except that the monomer emulsion was adjusted as indicated below:

Example 2 (comparative): 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.1 parts hydroxyethylcellulose (final polymer binder = 30% by weight polymer solids, average diameter 380nm, Tg = -20°C, and pH 8.1);

5 Example 3 (comparative): 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.1 parts polyvinyl alcohol (final polymer binder = 30% by weight polymer solids, average diameter 597nm, Tg = -20°C, and pH 8.1);

10 Example 4 (comparative): 45.6 parts by weight butylacrylate, 52.4 parts by weight methylmethacrylate, 1 part by weight adhesion promoter, and 1 part by weight methacrylic acid was polymerized in the presence of 0.5 parts sodium lauryl sulfate (final polymer binder = 30% by weight polymer solids, average diameter 120nm, Tg = -20°C, and pH 8.1);

15 Example 5 (comparative): 19 parts by weight butylacrylate, 80 parts by weight vinyl acetate, and 0.6 parts by weight hydroxyethyl cellulose, was polymerized in the presence of 1.5 parts mixed anionic and non-ionic non-polymerizable surfactants[(final polymer binder = 30% by weight polymer solids, average diameter 220nm, Tg = -20°C, and pH 8.1);

20 Example 6 (comparative): 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.1 parts by weight sodium lauryl sulphate (final polymer binder = 30% by weight polymer solids, average diameter 265nm, Tg = -20°C, and pH 8.1);

25 Example 7 (comparative): 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.1 parts by weight sodium lauryl sulphate (final polymer binder = 30% by weight polymer solids, average diameter 265nm, Tg = -20°C, and pH 8.1).

30 Example 8: 52 parts by weight ethylhexyl acrylate, 47 parts by weight methylmethacrylate, and 1 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40 (final polymer binder = 29% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 9.4).

Example 9: 52 parts by weight ethylhexyl acrylate, 45.5 parts by weight methylmethacrylate, and 2.5 parts by weight methacrylic acid in the presence of

0.1 parts by weight TREM LF-40 (final polymer binder = 29% by weight polymer solids, average diameter 261nm, Tg = -20°C, and pH 9.4).

Example 10: 52 parts by weight ethylhexyl acrylate, 44 parts by weight methylmethacrylate, and 4.0 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40 (final polymer binder = 29% by weight polymer solids, average diameter 254nm, Tg = -20°C, and pH 9.3).

Example 11: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5.0 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40 (final polymer binder = 30% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 8.2).

Example 12: 52 parts by weight ethylhexyl acrylate, 41 parts by weight methylmethacrylate, and 7.0 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40 (final polymer binder = 29% by weight polymer solids, average diameter 269nm, Tg = -20°C, and pH 8.0).

Example 13: 52 parts by weight ethylhexyl acrylate, 39 parts by weight methylmethacrylate, and 9.0 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40 (final polymer binder = 29% by weight polymer solids, average diameter 261nm, Tg = -20°C, and pH 9.4).

Example 14: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40 (final polymer binder = 30% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 8.2).

Example 15: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight TREM LF-40 (final polymer binder = 29% by weight polymer solids, average diameter 255nm, Tg = -20°C, and pH 8.0).

Example 16*: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.1 parts by weight allylammonium Lauryl-12EO-phosphate (Stepan X-2263-26; final polymer binder = 29% by weight polymer solids, average diameter 271nm, Tg = -20°C, and pH 8.3).

Example 17*: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight allylammonium Lauryl-7EO-phosphate (Stepan X-2263-27b; final polymer binder = 30% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 9.0).

Example 18*: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.1 parts by weight allylammonium Lauryl-3EO-phosphate (Stepan X-2263-28b; final polymer binder = 29% by weight polymer solids, average diameter 268nm, Tg = -20°C, and pH 8.7).

Example 19*: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight allylammonium linear-dodecyl benzene sulfonate (Stepan AU-1; final polymer binder = 29% by weight polymer solids, average diameter 258nm, Tg = -20°C, and pH 9.0).

Example 20*: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight allylammonium lauryl-sulfate (Stepan AU-5; final polymer binder = 29% by weight polymer solids, average diameter 245nm, Tg = -20°C, and pH 9.0).

Example 21*: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight allyl ammonium alkylether-sulfate (Stepan NMS-7; final polymer binder = 29% by weight polymer solids, average diameter 265nm, Tg = -20°C, and pH 9.0).

Example 22: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight ammonium Di-(tricyclo(5.2.1.0 2,6) dec-3-en-(8 or 9)oxyethyl) sulfosuccinate; final polymer binder = 29% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 8.6).

Example 23: 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of

0.2 parts by weight ammonium Di-(tricyclo(5.2.1.0 2,6) dec-3-en-(8 or 9) sulfosuccinate; final polymer binder = 28% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 8.8).

Example 24: 52 parts by weight ethylhexyl acrylate, 45.5 parts by weight

5 methylmethacrylate, and 2.5 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40, and 35g of 29% polymeric seed particles of 54nm size (final polymer binder = 29% by weight polymer solids, average diameter 217nm, Tg = -20°C, and pH 9.2).

Example 25: 52 parts by weight ethylhexyl acrylate, 45.5 parts by weight

10 methylmethacrylate, and 2.5 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40, and 23.5g of 23% polymeric seed particles of 54nm size (final polymer binder = 29% by weight polymer solids, average diameter 261nm, Tg = -20°C, and pH 9.4).

Example 26: 52 parts by weight ethylhexyl acrylate, 45.5 parts by weight

15 methylmethacrylate, and 2.5 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40, and 47.3g of 35% polymeric seed particles of 95nm size (final polymer binder = 28% by weight polymer solids, average diameter 280nm, Tg = -20°C, and pH 8.6).

Example 27: 52 parts by weight ethylhexyl acrylate, 45.5 parts by weight

20 methylmethacrylate, and 2.5 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40, and 33.5g of 32% polymeric seed particles of 95nm size (final polymer binder = 29% by weight polymer solids, average diameter 323nm, Tg = -20°C, and pH 9.2).

Example 28: In a similar manner to example 1 except 59 parts by weight

25 ethylhexyl acrylate, 36 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight TREM LF-40, (final polymer binder = 29% by weight polymer solids, average diameter 262nm, Tg = -31°C, and pH 9.0).

Example 29: In a similar manner to example 28 with 52 parts by weight

30 ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight TREM LF-40,

(final polymer binder = 29% by weight polymer solids, average diameter 263nm, Tg = -20°C, and pH 9.0).

Example 30: In a similar manner to example 28 with 45 parts by weight ethylhexyl acrylate, 50 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight TREM LF-40, (final polymer binder = 29% by weight polymer solids, average diameter 271nm, Tg = -6°C, and pH 8.0).

Example 31: In a similar manner to example 28 with 40 parts by weight ethylhexyl acrylate, 55 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight TREM LF-40, (final polymer binder = 29% by weight polymer solids, average diameter 263nm, Tg = 0°C, and pH 8.4).

Example 32: In a similar manner to example 28 with 30 parts by weight ethylhexyl acrylate, 65 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight TREM LF-40, (final polymer binder = 30% by weight polymer solids, average diameter 276nm, Tg = +20°C, and pH 8.8).

Example 33: In a similar manner to example 28 with 18 parts by weight ethylhexyl acrylate, 77 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight TREM LF-40, (final polymer binder = 30% by weight polymer solids, average diameter 289nm, Tg = +40°C, and pH 8.8).

Example 34: In a similar manner to example 28 with 8 parts by weight ethylhexyl acrylate, 87 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.2 parts by weight TREM LF-40, (final polymer binder = 30% by weight polymer solids, average diameter 261nm, Tg = +60°C, and pH 8.8).

Example 35: In a similar manner to example 29 with 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40, (final polymer binder = 30% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 8.2).

Example 36*: In a similar manner to example 29 with 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight acrylic acid in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 29% by weight polymer solids, average diameter 296nm, Tg = -

5 20°C, and pH 8.0).

261nm, Tg = +60°C, and pH 8.8).

Example 37: In a similar manner to example 29 with 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5 parts by weight oligomeric acrylic acid (Mw = 1400, prepared according to the process

10 disclosed in US-A-5710227 in the presence of 0.1 parts by weight TREM LF-40, (final polymer binder = 28% by weight polymer solids, average diameter 261nm, Tg = -20°C, and pH 9.2).

261nm, Tg = +60°C, and pH 8.8).

Example 38*: In a similar manner to example 29 with 52 parts by weight

15 ethylhexyl acrylate, 43.5 parts by weight methylmethacrylate, 3.0 parts by weight acrylic acid, and 1.5 parts by weight itaconic acid in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 30% by weight polymer solids, average diameter 276nm, Tg = -20°C, and pH 8.5).

Example 39*: In a similar manner to example 29 with 52 parts by weight

20 ethylhexyl acrylate, 43.5 parts by weight methylmethacrylate, and 5 parts by weight itaconic acid in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 29% by weight polymer solids, average diameter 264nm, Tg = -20°C, and pH 8.6).

Example 40: In a similar manner to example 14 with 52 parts by weight

25 ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5.0 parts by weight methacrylic acid in the presence of 0.2 parts by weight TREM LF-40 (final polymer binder = 30% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 8.2).

Example 41*: In a similar manner to example 14 with 52 parts by weight

30 ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5.0 parts by weight methacrylic acid in the presence of 0.1 parts by weight Stepan AU-1 (final

polymer binder = 29% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 9.6).

Example 42*: In a similar manner to example 41 with 52 parts by weight ethylhexyl acrylate, 42 parts by weight methylmethacrylate, 5.0 parts by weight methacrylic acid, and 1 part by weight 2-hydroxyethyl methacrylate (HEMA) in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 29% by weight polymer solids, average diameter 254nm, Tg = -20°C, and pH 9.0).

Example 43*: In a similar manner to example 42 with 52 parts by weight ethylhexyl acrylate, 41 parts by weight methylmethacrylate, 5.0 parts by weight methacrylic acid, and 2 parts by weight 2-hydroxyethyl methacrylate (HEMA) in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 29% by weight polymer solids, average diameter 272nm, Tg = -20°C, and pH 9.2).

Example 44*: In a similar manner to example 42 with 52 parts by weight ethylhexyl acrylate, 39 parts by weight methylmethacrylate, 5.0 parts by weight methacrylic acid, and 4 parts by weight 2-hydroxyethyl methacrylate (HEMA) in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 30% by weight polymer solids, average diameter 275nm, Tg = -20°C, and pH 9.0).

Example 45*: In a similar manner to example 42 with 52 parts by weight ethylhexyl acrylate, 35 parts by weight methylmethacrylate, 5.0 parts by weight methacrylic acid, and 8 parts by weight 2-hydroxyethyl methacrylate (HEMA) in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 29% by weight polymer solids, average diameter 250nm, Tg = -20°C, and pH 8.9).

Example 46*: In a similar manner to example 42 with 52 parts by weight ethylhexyl acrylate, 42 parts by weight methylmethacrylate, 5.0 parts by weight methacrylic acid, and 1 part by weight 2-hydroxyethyl acrylate (HEA) in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 29% by weight polymer solids, average diameter 266nm, Tg = -20°C, and pH 9.0).

Example 47*: In a similar manner to example 46 with 52 parts by weight ethylhexyl acrylate, 41 parts by weight methylmethacrylate, 5.0 parts by weight methacrylic acid, and 2 parts by weight 2-hydroxyethyl acrylate (HEA) in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 29% by weight polymer solids, average diameter 274nm, Tg = -20°C, and pH 8.7).

Example 47*: In a similar manner to example 46 with 52 parts by weight ethylhexyl acrylate, 41 parts by weight methylmethacrylate, 5.0 parts by weight methacrylic acid, and 2 parts by weight 2-hydroxyethyl acrylate (HEA) in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 29% by weight polymer solids, average diameter 274nm, Tg = -20°C, and pH 8.7).

Example 48*: In a similar manner to example 46 with 52 parts by weight ethylhexyl acrylate, 39 parts by weight methylmethacrylate, 5.0 parts by weight methacrylic acid, and 4 parts by weight 2-hydroxyethyl acrylate (HEA) in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 29% by weight polymer solids, average diameter 258nm, Tg = -20°C, and pH 8.7).

Example 49*: In a similar manner to example 46 with 52 parts by weight ethylhexyl acrylate, 35 parts by weight methylmethacrylate, 5.0 parts by weight methacrylic acid, and 8 parts by weight 2-hydroxyethyl acrylate (HEA) in the presence of 0.2 parts by weight Stepan AU-1 (final polymer binder = 29% by weight polymer solids, average diameter 225nm, Tg = -20°C, and pH 8.3).

Example 50: In a similar manner to example 14 with 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5.0 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40 (final polymer binder = 30% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 8.2). This sample was used as is.

Example 51: In a similar manner to example 14 with 52 parts by weight ethylhexyl acrylate, 43 parts by weight methylmethacrylate, and 5.0 parts by weight methacrylic acid in the presence of 0.1 parts by weight TREM LF-40 (final polymer binder = 30% by weight polymer solids, average diameter 270nm, Tg = -20°C, and pH 8.2). To a portion of this emulsion was post-added 1 equivalent weight of LiOH, and the NH₃ liberated was allowed to dissipate under enclosed air flow.

Example 52: To a portion of example 50 emulsion was post-added 1 equivalent weight of KOH, and the NH₃ liberated was allowed to dissipate under enclosed air flow.

Example 53: To a portion of example 50 emulsion was post-added 1 equivalent weight of NaOH, and the NH₃ liberated was allowed to dissipate under enclosed air flow.

Evaluation 1

This series of evaluations was prepared to demonstrate the improved print quality achieved when ink jet inks of the present invention are compared against ink jet inks comprising binders containing no polymerized surfactant monomer. The results are presented in Table 1.

From Table 1, it may be seen that the use of the polymerizable surfactant, Trem LF-40, in Polymer Binder of Example 1 gave a remarkable improvement in print quality than any of the other comparative systems. It is important to note that the non-polymerizable surfactant system used in Polymer Binder of Example 8 yielded poor print quality. It is also interesting to note that the optical density (OD) for the Polymer Binder of Example 1 was the best of the series as well.

Evaluation 2

This series of evaluations was prepared to demonstrate the effect of varying the acid level in the polymer binder of the present invention. The results are presented in Table 2.

The results in Table 2 indicate that OD, HR, and WR continue to improve as the acid level was increased, the print operability was poorer at 9% than at 5 or 7% MAA. While higher levels may be usable, especially with other acid monomers, we found the 5 to 7% level to be optimum for the overall balance of properties.

Table 1

5%MAA , 250 nm, Tg = -20

Example	Stabilization	Inkjet Formulation	Print Quality	Optical Density	Highlighter Resistance	Wet Rub	Print Operability	HP Printer
Example 1	TREM	1	3.9	1.18	3	3	3	540
Example 2	HEC	1	2.8	1.11	3	3	2	540
Example 3	PVOH	1	0	NA	NA	NA	0	540
Example 4	SLS	1	0	NA	NA	NA	0	540
Example 5	PVOH	1	0	NA	NA	NA	0	540
Example 6	SLS	1 / 2	2.8	1.12	3	3	3	540/690C
Example 7	SLS	1 / 2	2.8	1.13	3	3	3	540/690C

Table 2

0.1% TREM LF-40 , 250 nm, Tg = -20									
	Acid / %	Inkjet Formulation	Print Quality	Optical Density	Highlighter Resistance	Wet Rub	Long Term Printability (# of prints)	Print Operability	HP Printer
Example 8	MAA 1%	2	3.6	1.40	8	2	NA	0	690C
Example 9	2.5	2	4.0	1.36	8	3	NA	1	690C
Example 10	4.0	2	3.8	1.38	8	2	NA	1	690C
Example 11	5.0	2	5.3	1.39	10	3	1000 +	4	690C/890 C
Example 12	7.0	2	4.8	1.44	9	3	500	3	690C/890 C
Example 13	9.0	2	4.9	1.54	10	3	50	2	690C/890 C

Evaluation 3

This series of evaluations was prepared to demonstrate the effect of varying the polymerizable surfactant monomer in the monomer mixture used to prepare the polymer binder of the present invention. The results are presented in Table 3.

- 5 The results in Table 3 indicate all inks were printable and had good properties.

Evaluation 4

This series of evaluations was prepared to demonstrate the effect of varying the particle size of the polymer binder used in the inks of the present invention. The results are presented in Table 4.

- 10 Particle sizes from 200 to 350 nm were evaluated. The results in Table 4 show that over this narrow range of particle size, all samples were printable. The print quality of the 250nm variant was slightly better as was its HR and WR. OD seems to reach a minimum in this range. We could expect acceptable good print quality over a wider range of particle size.

15

Evaluation 5

This series of evaluations was prepared to demonstrate the effect on the ink of the present invention of varying the carboxylic acid monomer used in the monomer mix from which the polymer binder is made. The results are presented

20 in Table 5.

The results in Table 5 show that MAA appears to be the best for the overall balance of OD, WR, HR and print quality.

Table 3

	5% MAA, Tg = -20, 250nm Surfactant Type / level	Inkjet Formulation	Print Quality	Optical Density	Highlighter Resistance	Wet Rub	Print Operability	HP Printer
Example 14	TREM LF-40 / 0.1%	2	5.1	1.45	10	3	4	690C/890C
Example 15	TREM LF-40 / 0.2%	2	4.3	1.38	7	3	3	690C
Example 16*	STEPAN 2263-26 / 0.1%	2	5.3	1.46	10	4	3	690C
Example 17*	STEPAN 2263-27B / 0.2%	2	4.8	1.43	10	2	3	690C
Example 18*	STEPAN 2263-28B / 0.1%	2	5.4	1.49	10	4	3	690C
Example 19*	STEPAN AU-1 / 0.2%	2	5.6	1.50	10	4	4	690C/890C
Example 20*	STEPAN AU-5 / 0.2%	2	5.4	1.49	10	4	3	690C
Example 21*	STEPAN NMS-7 / 0.2%	2	5.1	1.45	10	3	3	690C
Example 22	ammonium di-(tricyclo(5.2.1.0 2,6) dec-3-en-(8 or 9) oxyethyl) sulfosuccinate	2	5.1	1.41	10	3	3	690C
Example 23	ammonium di-(tricyclo(5.2.1.0 2,6) dec-3-en-(8 or 9) sulfosuccinate	2	4.3	1.42	6	4	3	690C

Table 4

2.5% MAA, 0.1% TREM, Tg = -20

	Particle Size	Inkjet Formulation	Print Quality	Optical Density	Highlighter Resistance	Wet Rub	Print Operability	HP Printer
Example 24	217	2	3.5	1.38	6	2	2	690C
Example 25	261	2	4.5	1.36	8	3	3	690C
Example 26	280	2	3.0	1.34	5	1	2	690C
Example 27	323	2	3.6	1.44	5	3	2	690C

Table 5

250nm, -20 Tg, 5% acid

	Acid Type	Surfactant	Inkjet Formulation	Print Quality	Optical Density	Highlighter Resistance	Wet Rub	Print Operability	HP Printer
Example 35	MAA	TREM, 0.1%	2	5.6	1.40	10	4	4	690C/890C
Example 36*	AA	AU-1, .2%	2	4.5	1.38	7	4	3	690C
Example 37	o-AA	TREM, 0.1%	2	4.7	1.32	10	3	2	690C
Example 38*	1.5% IA / 3.0% AA	AU-1, .2%	2	5.1	1.42	10	3	3	690C
Example 39*	IA	AU-1, .2%	2	5.1	1.42	10	3	3	690C

Evaluation 6

This series of evaluations was prepared to demonstrate the effect of varying the glass transition temperature of the polymer binder used in the inks of the present invention. The results are presented in Table 6.

- 5 The results in Table 6 show that Tg has little effect on print operability. OD appears to improve with higher Tg, and HR and WR appear to improve with lower Tg. The WR and HR performance improves as Tg is lowered to somewhere between -6C and -20C (between ca. 15 and 40C degrees below ambient temperature). Below this point, the WR and HR do not improve. Using a
- 10 coalescing solvent and/or a high temperature fuser, we can get outstanding WR performance from the Tg=60C sample. There appears to be no inherent limit on how far one can increase the Tg and still get adequate WR using coalescing/fusing of the printed ink.

Evaluation 7

- 15 This series of evaluations was prepared to demonstrate the effect of varying the hydrophilic nature of the polymer binder used in the inks of the present invention. The results are presented in Table 7.

Hydrophilic monomers HEA and HEMA were added to the polymer backbone composition in an attempt to improve print quality. The expectation was that a

20 more hydrophilic composition would improve the rewet of material encrusted on the printhead and possibly improve the latex particle dispersion as well. Our data in Table 7 shows that WR, HR, OD and print quality all become poorer as the level of hydrophilic monomer is increased. However, acceptable performance can be obtained in the presence of these monomers.

Table 6

5% MAA, 0.2% TREM, 250nm

	Tg	Inkjet Formulation	Print Quality (fused/unfused)	Optical Density (fused/unfused)	Highlighter Resistance (fused/unfused)	Wet Rub (fused/unfused)	Print Operability	HP Printer
Example 28	-31	2	5 0	1.39	10	3	3	690C
Example 29	-20	2	5 3	1.40	10	3	4	690C
Example 30	-6	2	4 6	1.45	8	3	3	690C
Example 31	0	2	3.3/2.6	1.44/1.45	3/2	4/2		690C
Example 31A	0	2	3.8/2.6	1.44/1.46	5/2	4/2		
Example 32	20	2	3.4/2.1	1.53/1.47	3/1	4/1		690C
Example 33	40	2	3.6/2.1	1.49/1.46	4/1	4/1		690C
Example 34	60	2	4.1/2.2	1.50/1.46	6/1	4/1		690C

Table 7

250 nm, 5% MAA, 0.2% STEPAN AU-1(unless indicated)

	Monomer	Inkjet Formulation	Print Quality	Optical Density	Highlighter Resistance	Wet Rub	Print Operability	HP Printer
Example 40	None	2	5.6	1.40	10	4 0 1% TREM Lf-40	4	690C
Example 41*	None	2	5.3	1.39	10	4	3	690C
Example 42*	1% HEMA	2	5.1	1.40	10	4	2	690C
Example 43*	2% HEMA	2	5.1	1.40	10	4	2	690C
Example 44*	4% HEMA	2	4.3	1.38	8	3	2	690C
Example 45*	8% HEMA	2	4.2	1.30	8	3	2	690C
Example 46*	1% HEA	2	4.6	1.40	9	3	2	690C
Example 47*	2% HEA	2	4.6	1.43	8	4	2	690C/890C
Example 48*	4% HEA	2	4.2	1.33	7	4	2	690C
Example 49*	8% HEA	2	0	NA	NA	NA	0	

Evaluation 8

This series of evaluations was prepared to demonstrate the effect of varying the binder neutralization in the inks of the present invention. The results are presented in Table 8.

All previous binder preparations were made with ammonia for in-process neutralization. In this series, we used different alkali metal hydroxides to complete the neutralization of the formulated inks. Some advantages were seen for ammonia and sodium for OD, WR and print quality.

Evaluation 9

This series of evaluations was prepared to demonstrate the effect of varying the pigment used in the inks of the present invention. The results are presented in Table 9. The results in Table 9 suggest that the effects that we have seen with carbon black pigmented inks of the present invention are repeatable with other pigments.

Table 8

Binder neutralization, 250nm, 5% MAA, 0.1% TREM LF-40

	Base	Inkjet Formulation	Print Quality	Optical Density	Highlighter resistance	Wet Rub	Print Operability	HP Printer
Example 50	NH3	2	5.3	1.41	10	4	3	690C
Example 51	LiOH (post add)	2	4.9	1.25	10	4	2	690C
Example 52	KOH (post add)	2	4.7	1.27	10	3	2	690C
Example 53	NaOH (post add)	2	5.3	1.37	10	4	3	690C

Table 9

Ink Formulation	gms	Dispersion Color	Print Operability
n-MP	1.6	cyan - Polytribo Acryjet 157	2
PEG	1.0	magenta - Polytribo Acryjet 127	2
EG-1	0.5	yellow - Polytribo Acryjet 747	2
Propanediol	1.2		
Dispersant	6.2		
Surfynol 104E	0.1		
Example 50	5.0		
DI water	14.2		

Claims:

1. A polymeric binder suitable for use in an ink composition, comprising a colorant and a polymeric binder, wherein the polymeric binder is an emulsion-polymerized addition copolymer formed from a monomer mixture comprising ethylenically unsaturated monomers including from more than 4 to 15 wt % based on the weight of said mixture of at least one ethylenically unsaturated carboxylic acid functional monomer, and from 0.05 to 5 wt % based on the weight of said mixture of at least one polymerizable surfactant monomer comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it.
2. A polymeric binder as claimed in claim 1, wherein said hydrophilic functional group comprises within it a polymerizable group which is an ethylenically unsaturated amine cation.
3. A polymeric binder as claimed in claim 2, wherein the polymerizable surfactant is selected from the group of polymerizable surfactant monomers consisting of allylammonium C₈-C₂₂ alkyl -12EO-phosphate; allylammonium C₈-C₂₂ alkyl -7EO-phosphate; allylammonium C₈-C₂₂ alkyl -3EO-phosphate; allylammonium linear-dodecyl benzene sulfonate; allylammonium lauryl-sulfate; and allyl ammonium alkylether-sulfate or allyl ammonium salts of C₈ - C₂₂ carboxylic acids, allyl ammonium salts of succinate or maleate ester surfactants.
4. A polymeric binder as claimed in claim 1, wherein the acid functional monomer is one or more monomers selected from the group consisting of C₃ to C₂₀ ethylenically unsaturated carboxylic acids, their basic salts, and mixtures of such monomers.
5. A polymeric binder as claimed in claim 1, wherein said monomer mixture comprises one or more monomers selected from the group of monomers consisting of substituted and unsubstituted (C₁ to C₅₀) alkyl (meth) acrylates, styrene and substituted styrenes, vinyl acrylates, vinyl acetates, fluoromethacrylates, acrylamide, substituted acrylamides, and methacrylamides, substituted methacrylamides.

6. An ink composition comprising a colorant and a polymeric binder wherein the polymeric binder is an emulsion-polymerized addition copolymer formed from a monomer mixture comprising ethylenically unsaturated monomers including from more than 4 to 15 wt % based on the weight of said mixture of at least one ethylenically unsaturated carboxylic acid functional monomer, and from 0.05 to 5 wt % based on the weight of said mixture of at least one polymerizable surfactant monomer comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it.
7. An ink composition as claimed in claim 6, wherein said ink composition is an ink jet ink.
8. A method of improving the print quality of an ink composition, which method comprises formulating said composition by incorporating therein a polymeric binder formed by polymerizing a monomer mixture comprising ethylenically unsaturated monomers including from more than 4 to 15 wt % based on the weight of said mixture of at least one ethylenically unsaturated carboxylic acid functional monomer, and from 0.05 to 5 wt % based on the weight of said mixture of at least one polymerizable surfactant monomer comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it..
9. A method as claimed in claim 8, wherein said ink composition is an ink jet ink.
10. Use in the preparation of an ink composition of a polymeric binder formed by polymerizing a monomer mixture comprising ethylenically unsaturated monomers including from more than 4 to 15 wt % based on the weight of said mixture of at least one ethylenically unsaturated carboxylic acid functional monomer, and from 0.05 to 5 wt % based on the weight of said mixture of at least one polymerizable surfactant monomer comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it, to improve the print quality of said ink composition.

11. Use as claimed in claim 10, wherein said ink composition is an ink jet ink composition.

12. Use as claimed in claim 10, wherein said ink composition is an ink jet ink composition.

ABSTRACT OF THE INVENTION

POLYMERIC BINDERS FOR INK JET INKS

An emulsion-polymerized addition copolymer formed from a monomer mixture comprising ethylenically unsaturated monomers including from more than 4 to 15 wt % based on the weight of said mixture of at least one ethylenically unsaturated carboxylic acid functional monomer, and from 0.05 to 5 wt % based on the weight of said mixture of at least one polymerizable surfactant monomer, comprising hydrophobic and hydrophilic functional groups, wherein said hydrophilic functional group comprises a polymerizable group within it, is useful as a binder in an ink jet ink having improved print quality.

Docket Number 99-078

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am

☒ [X] the original, first and sole inventor

☐ [] an original, first and joint inventor

of the subject matter which is claimed and for which a patent is sought on the invention entitled POLYMERIC BINDERS FOR INK JET INKS, the specification of which

☐ [] is attached hereto.

☒ [X] was filed on December 14th, 1999 as

Application Serial No. 60/170,555

and amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Patent and Trademark Office information known to me to be material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

☐ [] I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Application No.	Country	Date of Filing (day, month, yr.)	Priority Claimed yes/no

[X] I hereby claim priority benefits under Title 35, United States Code, §119(e)(1) of any provisional application for patent listed below and have also identified below any provisional application for patent having a filing date before that of the application on which priority is claimed:

Provisional Appl. No.	Date of Filing (day, month, yr.)	Priority Claimed yes/no
60/170,555	14 December 1999	yes

[] I hereby claim the benefit under Title 35, United States Code, §120, of any United States application(s) listed below, and insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose to the Patent and Trademark Office information known to be material to patentability of this application, as defined in Title 37, Code of Federal Regulations, §1.56, which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.	Date of Filing (day, month, yr.)	Status - Patented, Pending, Abandoned

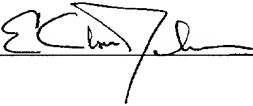
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I hereby appoint the following attorneys and agents to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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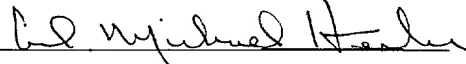
Date 3/1/00

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Full name of inventor Carl Michael HESLER

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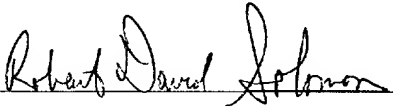
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